POSSIBILITIES OF COMMUNICATION IN INFORMATION AND CONTROL SYSTEMS

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Abstract: This article takes an interest in communication possibilities in Information and Control Systems (ICS), focused on visualization and control SCADA/HMI systems. It describes the way of the communication between Suite Voyager Industrial Server and external devices or models. It contains descriptions of configurations and description of structures which we have built in our department. We also describe communication protocols which we use and combine in our solution. At the end, these possibilities are compared and there are described our practices.

Keywords: visualization, SCADA/HMI, communication possibilities, Information and Control Systems

1. INTRODUCTION

The communication interfaces and protocols used for the connection of particular sub-systems, which form the information and control system (ICS), include the main part of these systems and the whole system depends, from big part, on the stability and characteristics of these interfaces and protocols. In the following paragraphs there will be described briefly the control and information system of our department, as well as some of its elements and ways how these sub-systems are connected and what is our experience with the described types of the interfaces and protocols.

2. BASIC CONCEPTS

2.1 The information and control system DCAI

At the Department of Cybernetics and Artificial Intelligence (DCAI), the Faculty of Electrical Engineering and Informatics of the Technical University in Košice, the unique model of information and control system (ICS) that is in the department community often called also Distributed Control System (DCS) was laboratory made. Its physical model is shown on the Fig. 1 (Dubecký, 2006). In a logical model the server cybernetics.fei.tuke.sk serves partly for the implementation of the information level and partly for the implementation of the visualization (SCADA/HMI) level. This ICS is physically distributed in more laboratories and has three hierarchic logical levels (Dančíková, 2007):

- Process (Technological)
- Visualization (SCADA/HMI)
- Information

The output of the whole system is proposed in form of the number data, visualizations and graphic statistics that co-operate interactively with the user (Bakoš, 2005). These outgoing data are provided by a joint server cybernetics.fei.tuke.sk where the portal Suite Voyager is installed. This portal then executes the data from the databases and provides these data remotely to other users that are allowed to collect them. It facilitates the display and interaction with the system of real and simulated models by some visualization, alarm imaging and their acknowledgement, the work with the real and historical trends, etc. (Landryová, 2004). Every subsystem keeps at its disposition the graphical

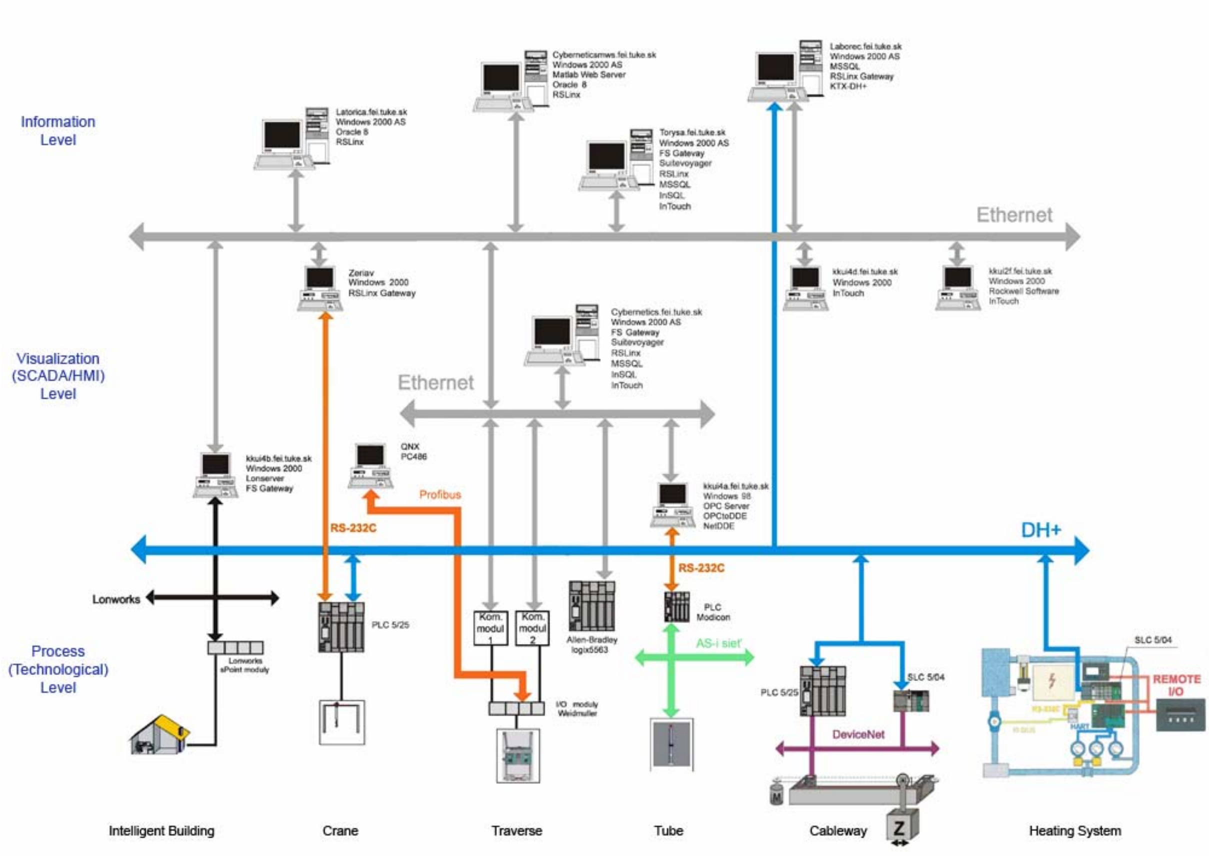

Fig. 1. Physical model of Information and Control System (ICS)

visualization of the process with control panels and some of them provide a possibility of a regressive reaction by IP Web camera.

For contemporary systems SCADA/HMI communication with associated systems on vertical and horizontal levels within the frame of ICS is typical (Leleve et al., 2003). The basic aim was to collect the data from technological processes. It was increased by their saving in the databases, followed by the execution of these data whether in graphical or in statistical number results form and their display (Babiuch, 2004). Nowadays the systems SCADA/HMI are known under the name visualization systems, which are caused by their typical, big ranged, graphic interface human-machine (Bakoš, Zolotová, Sarnovský, 2005). They play the role of subsidiary instrument for the user in the control and operating. In the name of these systems there are also mentioned three fields which properly correspond with creating of logical models and on their basis also physical models. Nowadays, the logical model is formed mainly by following sub-systems (Huba, Bisták, Záková, 2004):

- **HMI** – Human Machine Interface
- **SC** – Supervisory Control
- **DA** – Data Acquisition

***HMI** – Human Machine Interface* – facilitates the entrance to the system with various entrance rights, facilitates also the orientation of the user in a controlled process and mediates mutual interaction with controlled system and other associated systems by means of visualization; obtained data are then provided in a graphical and number version (e.g. alarms, trends, statistical graphs, system events, helping texts, etc.) (Masár, Bischoff, Gerke, 2004).

***SC** – Supervisory Control* – this sub-system includes the possibility of remote control (e.g. change of the parameters of a remote system), action members control, sequence processes control, signalization of the rise of warning and alarm (critical rates), their confirmation, execution of actual and historical process data in real time, enumeration of statistical information for quality process monitoring and control, machine diagnostics, etc.

***DA** – Data Acquisition* – provides data gathering about the process and process control system, information and knowledge saving to the databases (of various types) and their Exchange with associated systems.

As it is possible to see in the Figure 1, in frame of our ICS there are some real models connected. Those are the models that were connected with the server cybernetics.fei.tuke.sk and from those the data are obtained, executed and forwarded. We will describe them briefly:

Cableway – moulds industrial machine for transfer of melt, liquid iron at fusion in blast furnace. Cableway serves for transferring the load (carriage) to a required position either automatically to the required value of the position or by control buttons for the displacement of the model to the right or left during which time it is possible to stop it immediately. Model regulation is possible directly on the supervisory server or by means of a thin client.

Intelligent Building – it is a simplified model of a building, comprised of the two autonomous rooms where, in the top part of the object, the temperature and in the bottom part lighting is regulated. Model control is possible directly on the local computer where there is a program Lon Server 3.0.0 installed or by thin client.

Heating system – is the model of primary side of an exchanger for water heating for a central heating or for warm used water heating. It represents closed circulation of warm water. The water gains from spirals some amount of warmth which it gives away to the water on the secondary side of the exchanger. The control of the model is possible either locally by SLC automation and screen desk, directly on the server, or by means of thin client.

Magnet – this model serves for simulation of some logical control. By means of magnet, placed above rotary disk, the transmitted entity (iron bullet) is transmitted to one of the six positions. This is made by pulling the entity to the magnet and, after swinging the disk to the required position; this entity is released and put to the required position. The model is possible to control by a local computer directly on the server or by means of a thin client.

Tube – the model of the entity in an air tube serves for a proposal and realization of the control which controls the altitude of the entity (ball) in the tube. This happens under the conditions when the tube declines to various angles by which case, under the influence of the friction on the walls of the tube, comes to a control mistake. It is possible to control the model through a local computer, directly on the server or by a thin client.

All of these real models were created with a self–support of the department. Their development was shared by the pedagogues, diploma students and students of the department of Cybernetics and Artificial Intelligence.

3. COMMUNICATION INTERFACES AND PROTOCOLS USED IN OUR ICS

At the implementation of these models to ICS it was necessary to provide the data transmitting from the particular models to the server executing these data for administration to the users that are registered in the system. Afterwards it executes also the administration backwards from the server, according to the interactive clients´ requests to the particular models. Between the models and the server, better to say, between the model and the local control computer, there are various transmitting protocols and communication tools that will be described used. The nets used directly in the models are not described here. Followingly there will be compared and briefly compiled the characteristics and our experience with these communication interfaces and protocols, which were used here. It concerns the communication protocols OPC, DDE, Suite Link, TCP/IP, networks of the type ASI, DH+, DH485, Lon Works, Ethernet, serial line RS232, communication gateways, tools Factory Suite Gateway, RS Linx, etc. These protocols will now be described and directly at these descriptions there will be mentioned also their characteristics and our experience, eventually the exact description of how and where they were implemented.

3.1 Communication protocols

OPC – OLE For Process Control – is concerned to be an industrial standard mechanism for communication and co-operation of various data sources with client applications for technological process control. OPC has character of a communication client/server. We used, for the acquisition of data from automatic machine, the protocol of a company Schneider, which provided the data to a computer through OPC server and these are followed by the instrument Factory Suite Gateway converted and sent by means of the protocol Suite link on supervisory server cybernetics.fei.tuke.sk, where they are read by a program Wonderware InTouch and by a database Wonderware InSQL, which take care of visualization of the data and their saving to the industrial database. From these data it is then generated also the output of the industrial portal Suite Voyager. By the connection of these protocols we obtained one of the simplest possibilities of an interconnection, seeing that it considers computers set in various laboratories, because there is not any more comfortable possibility which would be provided by the given machineries. Stability of the connection is very good, what indicate data saved in database, considering small percentage of non-transmitted data due to more or less intervention of the operation and the service restart of the server.

DDE – Dynamic Data Exchange – that is communication protocol created by the company Microsoft, which makes it possible to applications in environment of the operating system Windows to send and receive data and instructions within individual applications mutually. Between the two simultaneously running applications realize a relation of the type client/server. This protocol is from protocols, which we used for the implementation the most used. As it was at protocol DDE these are sent/received through the program Factory Suite Gateway to the server cybernetics.fei.tuke.sk, where there are saved in databases Wonderware InSQL, used by the program Wonderware InTouch to the direct visualization and through the portal Wonderware Suite Voyager accessed to the wide public. Thereby the protocol there are on local computers provided data also to other applications.

Suite Link – is protocol by company Wonderware. It is based on the basis of TCP/IP, which is used by the Microsoft. Suite Link is developed especially for the needs high velocity industrial applications, as data integrity, high transmittivity and easier diagnostics of data transmittance, server load, capacity utilization of the computer sources and network transport, performed in collaboration with Microsoft Windows. The usage of the protocol is described at protocol OPC. We found the use especially at transmission through networks Ethernet, among several remote networks, where it helped us to substitute already unused communication protocol NetDDE.

TCP/IP – Transmit Control Protocol/Internet Protocol – is one of the main network protocols. Its functions are connection service, reliability of the transmission of the data and their safekeeping, effective use of the communication channels, transparent and fully duplex transmission, etc. The protocol was in our ICS used for mutual connection of the central computer with the local ones that serve for the control, local treatment and visualization of all the described models.

3.2 Communication interfaces, networks

ASI – Actuator Sensor Interface – it is the interface of sensors and action units. It supports particularly binary, but also analogue sensors and action units at completely lowest level of automation. In our ICS yourself this network found its application as it is possible to see in the Figure 1, at communication with the Models Tube and Magnet. These data are gained from modules of the network ASI provided to the local computer and to the server are mediated by the progress described at OPC protocol. With network and its implementation we did not have bigger problems.

Lon Works – Local Operation Network – is the locally working network. This network results from the connection (by communication data medium) of the group of intelligent items (named also network nodes). It is concerned to be decentralized network i.e. to its activities does not need any central operative unit. It consists of particular nodes (these nodes have in them implemented specific intelligence and in one network they are unique, independent and equivalent), which communicate with one another independently. This network is in our ICS applied at the model Intelligent Building, where it serves as an operative network for the control of the heating and lightning in two autonomous rooms. The technique, which we used to realize the transfer of these data, is described in part about the protocol DDE.

DH+ – is concerned as a local, very simply implementable network. It was designed for communication among PLC, SLC and computers. Data from this network are to/from computer gained by DH+ communication card, which transmits/submits the data through the program RSLinx Gateway. These communication data are consequently distributed through the network Ethernet and other computers them obtain through the medium of the program RS Linx namely in form of the OPC or DDE. Through this network and program alignment RSLinx Gateway are in our ICS read data e.g. from the model Cableway and these are consequently sent/received by network Ethernet and the protocol TCP/IP to the supervisory server cybernetics.fei.tuke.sk, where they are by the help of the program RSLinx and the protocol DDE provided by already mentioned program from company Wonderware.

Ethernet – is concerned one of the most used (80% installations) local networks, which realizes a layer of the network interface. Its popularity is reflection simplicity its protocol and thereby also easy implementation and installation. There are more versions, modifications of this network and also types of the used communication media, indeed it will not be deeper analyzed by our work, because it is not the task of the article.

3.3 Communication gateways, tools

Factory Suite Gateway – is a universal Software communication gateway, which simplifies the integration of the applications to those, that makes it possible to communicate with applications (by the data servers) supporting protocols OPC, Suite Link, DDE and Message Exchange and the data of these applications exchange to the client's application, which support protocols OPC, Suite Link or DDE. This communication port is possible with product of the company Wonderware used without restraints.

RSLinx Gateway – it is a software communication gateway which makes the communication among PLC, SLC and computers by DH+ communication card in our case possible.

Specific use of these software tools was described at the description of the communication protocols and networks, which we in our ICS used for the implementation of its physical model.

4. CONCLUSION

From our skills with specific protocols and networks there rose, from the connection of the models, local working stations and the supervisory server through protocols and networks, which provide us very good results from the point of view of the stability, as well as from view of relatively fast transmitting and from this resulting velocity data storage and interaction of the user with the models, whether through the thin client or straight through supervisory server. The most used communication protocol in frames of the local interconnection of the applications has in our system been the protocol DDE. For data transmission by means of the network Ethernet and the protocol TCP/IP we have gained very good results by the use of the communication protocol Suite Link and application Factory Suite Gateway. With the regard on the protocol stability and its wider usage possibilities in similar systems the protocol OPC, which showed very good properties, is also convenient. Each of the technological networks DH+, LonWorks and ASI is based on different ways of communication but with the help of protocols which have been used for their rebindness is working reliably in our system and so their cover trouble free running of whole the system. Results, which rose from our implementation, are for us sufficient and in the short period of time they will incorporated to the further models, which amplify our ICS.

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